Baggage Traffic Control in Airports Making Use of RFID Technology

Mostafa Tavassoli, Abolfazl Rajabi, Mehrdad Javadi, Sasan Mohammadi

Abstract*— Nowadays, automatic identification of components is one of the most important research fields for researchers and scientists in different arenas. RFID Technology is one of the technologies widely used in this arena. For this purpose, the present research has dealt with this technology as a means of tracking and identifying baggage automatically in a traffic control system in an airport. The specification of RFID Technology helps distinguish between man and objects with high precision. This paper makes use of this capability for identifying and tracking baggage in an airport and plane in order to increase the efficiency of luggage transport system, which, as a result, increases the precision of the system, decreases the damages arising from the missing of the luggage and its wrong transport and decreases the errors of the manpower. In order to obtain an intelligent system and automatically identify objects, a unique number is required for tracking and control each object. This research has defined a new model with four choices (that is, airline name, flight number, nature of tag and chair number) in order to develop a unique identity number. This number is stored in the tag memory. With such tags passing through RFID Readers embedded at different places including the conveyor belt or at the gates, passengers' luggage may be easily tracked. This way, any problem can be easily dealt with. Thanks to its adaptability, this technology can be easily used in computerized network for sending and receiving information; and an information bank has also been used to instantaneously analyze and study the information.

***Index Terms*— BHCS (Baggage Handling Control System), Tag Patterns, Unique Identity Number.**

I. INTRODUCTION

Nowadays, airplane is one of the most common means of transport for people all over the world. With a precise look at this topic, one can come to the conclusion that sometimes the occurrence of several problems in this industry has caused many damages to different airlines companies. Such problems can be removed making use of state of the art technology and knowledge. According to the statistics of IATA in 2010, this industry has incurred over US$ 2.5 billion damages arising from the missing of passengers' luggage [1]. The development of the transport industry has caused many substantial changes in the world as compared to the past. And by considering this point, we come to the conclusion that airports will be substantially changed compared to the past. Generally, an airport can be defined as a system that is to say, in this system, all components should properly and together work to achieve a common objective. And if one of these components fails, the whole system becomes disordered or does not reach its favorite results. Baggage Handling Control System (BHCS) is one of the most important components of an airport, which can be alone defined as a system [3]. This paper will study this system. The main objective of this system is to transfer the choices entered into the input system to its output. And the most important factor, which made "baggage displacement system" interesting for study is an environment where the system become operational [4]. At present, this system is used in airports traditionally, that is, the use of barcode system for baggage and passenger transport, which is an old and traditional method with high error percentage [5]. In this system, transport operation is conducted at very low speed and precision. For reading and control of barcodes, barcode readers need to carefully read barcodes in direct sun light. One of the main disadvantages of this method is that it can only identify one item at a time, and the average of the reading precision of this method has been estimated to be between 75% and 90 % in the best manner. There have been many attempts to solve these problems. Yet, airlines and IATA came to the conclusion that the use of RFID in this system is one of the best ways to decrease the problems [6]. The technology was first used in the World War II to identify enemy's warplanes [7]. But, now, with this technology becoming widespread, it is widely used in customer supply chain, goods inventory tracking, management, libraries, agriculture, medical affairs and many other fields [8-10]. The technology can change a tagged element into an intelligent and dynamic tool connecting it to an organizational information structure [11]. With this technology being used, the disadvantages of traditional system have been largely removed. Meanwhile, with its precision in reading tags and its ability to identify several items at a time, it will chiefly increase the speed, efficiency and precision of the system in transporting baggage. One of the major problems in the airports which has caused irreparable damages to airlines is the missing of passengers' baggage and/or their mistakenly transport. This technology can be easily used to pursue all the baggage in airports and even planes to avoid their mistaken transfer. In [12], RFID is considered not only as an acceptable, cost effective and new candid for identifying objects, but also as a reliable tool to track at different stages along an air supply chain. In the transport of baggage, RFID tags are used to raise the ability to track the baggage, their transport. And as a result these tags increase the management effect as well as customer satisfaction. This study reviews the applications of RFID Technologies as well as provides reports on the manner of effect on the management of transport and delivery of baggage and the increase in the services rendered to customers.

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This operation has been completed in a four-component structure. The presentation of RFID Technology as a widespread technology in automatic identification and tracking and recognition of all objects identify an object or a person at a certain distance making use of electromagnetic change [14, 15]. Meanwhile, in [16], RFID is deemed as a growing technology, which paves the way for the radio identification of objects and the reading of their related tags without needing to directly looking at the tags. In [17], RFID is construed as a new and state of the art technology with many practical applications in various industries. Owing to its properties such as dynamism, organization, state of being systematic, the technology has been warmly welcomed. Such an attention has caused a great revolution in IT. During the recent years, due to the widespread use of this technology in many airports, there have been many studies conducted by different researchers to review and analyze the place of tags and the manner of sticking them on baggage. In the preliminary study, tags were stuck on suitcases. But in [18], after the conduction of different and various tests, it was concluded that the best place for sticking tags is the wall of a suitcase. In [19], a series of results are shown and it is finally concluded that the best place for sticking tags is the wall of a suitcase. The paper conducted a test and determined the reading rate of tags to be 100%. This result has been obtained by the reading antennas in a distance less than that of the common RFID [20]. Ordinary UHF RFID tags make use of an ordinary bipolar structure for testing in an airport. Although they do not guarantee the best score in tag reading, the main objective of this study is to develop tags as a proprietary solution based on three-dimensional geometry [21]. In all industries, customers' satisfaction with the system's services has the last word. The article [22] it is believed that the provision of services for customers is one of the most important characteristics of service supply chain; and RFID may join the service supply chain through increasing services to the customers. This study finally tests and uses RFID in a real sample, describes the applications of this technology and introduces RFID as a service to customers in two external and internal manners.

Relying on RFID Technology and making use of Passive Tags, the present research designs a complete BHCS System in four designing and simulation stages and each section has its own function. The first section will deal with the definition manner of tags and definition of a proprietary pattern for storage in tags and information bank, base on which, tracking and controlling are easily conducted in the system. The second section deals with the review of security in the system as well as the management in unsafe conditions of the system. In the third and fourth sections, we deal with the manner of merging the baggage transferred and the baggage entered into the system. And we finally deal with the manner of conforming baggage to passengers. Finally, simulation is made, a conclusion is drawn from the hypotheses and the RFID Technology-based system is compared with the traditional system.

II. SOFTWARE & HARDWARE REQUIREMENTS

Given that, for its design and implementation, each project is in need of the meeting of the software and hardware requirements, we review such requirements in this section of the paper. RFID Read/Write, UHF Passive MR6011, is the most important hardware that constitutes the basis of the study. Its specifications are provided in Table 1. The tags used here are passive. The standard frame of these tags will be studied in the next section. All these parts are in need of a wireless network and a powerful host for storing information for sending, keeping contact with one another, managing and storing. A computerized network of Wi-Fi easily meets our requirements in this field. This project requires a very powerful information bank such as SQL Server and/or Oracle to store the information of passengers and their baggage at their arrival in airports, to take query if needed and to conduct all the related operation. Here, we make use of SQL Server for storing and registering information.

Table1 Properties Of RFID UHF Passive MR6011

Model	MR6011A
Protocol	ISO 18000-6B , ISO 18000-6C (EPC Gen2)
Frequency Rang	StandardISM 902 ~ 928MHZ Or ISM 865~868MHZ, Other Frequence Available
Data Ports	RS485,RS232; Software Programmable,Custom-mode : WI-Fi, RJ45
Reading Range	Max 12m
Power Supply	DC+ 9V (Power Adapter)

III. DESCRIPTION OF PROBLEM

A. Input and Registration of Information

Description of such a system depends on huge expenses and high precision. In the architecture of this system, the objective is to meet the customer's need and to provide better services regarding the customer supply chain. Generally, when passengers arrive at the airport, they first head to the check-in section to deliver their luggage. At check-in section, the information of each and every passenger is taken and stored in an information bank. Considering the information each passenger has provided, an identification number is made for them. This identification number is considered as a code, which is kept in a tag peculiar to each person. The number produced should be stored in the memory related to RFID tag for any further investigation and referral to the information of the passengers and their luggage. This project has defined and designed a pattern for making and storing that code. To this end, four important items including name of the airlines, flight number, tag nature (passenger, handbag, and suitcase) and seat number, are used to make and store this code. Fig. 1 shows the standard frame of an EPC Tag [23].

Header	Filter	Company Prefix	Item Ref	Serial Number	Reserved
8 bits	8 bits	12 bits	4 bits	40 bits	24 bits

Figure 1 Data allocation for a 96**bit EPC standard**

In the present study, the first eight bits, that is, Header is defined as the nature of the tag. The amount of (00111111) is, for instance, stored in the system. Meanwhile, handbag is the very luggage a passenger may carry with themselves into the plane. In this model, the amount (01111111) is introduced in the system. In order to separate different natures and to easily access them for each passenger, the amount (11111111) is stored in the memory of the tag. A related sample is shown in Fig. 2.

Header							
0	0	1	1	1	1	1	1

Figure 2 **Header Identifies a Baggage Tag**

As a result, one can grasp the nature of a tag by referring to Header. In the next 12 bit entitled Company Prefix, the airline name is entered. The amount (01111100111) being equivalent to number 999, is, for instance, defined for Mahan Airline. These bits are defined as the sample shown in Fig. 3.

Company Prefix											
0	0	1	1	1	1	1	0	0	1	1	1

Figure 3 **Company Prefix Identifies a Airline Ticketing number**

Finally, in the section of Serial Number, flight number and seat number are introduced to the system. This section has 40 bits, from right, the first 12 bits are stored as flight number and the second ten bits as passenger seat number. Flight No. 1087 of Mahan Airline and Seat No. 25A are shown as an example in Fig. 4.

Serial Number																																							
																		Seat Number										Flight Number											
																		0	0	1	1	0	0	1	0	0	1	0	0	1	0	0	0	1	1	1	1	1	1

Figure 4 **Serial Number Identifies a Seat and Flight Number**

B. Security of System

One of the most important sections of each system is its security and control in case of occurrence of any insecure situation in the system. In the intended system, after the making of tags and the sticking of them to baggage, passengers' baggage is passed through a box including four RFID Readers. In case of the specifications related to baggage not confirmed in the system, such baggage is returned to the previous stage and its tag is studied and a new tag is stuck to it if necessary. As a routine, all suitcases should be passed through EDS System to observe their contents. This process is conducted in the intended system as well. In case of any insecure condition, the related suitcase should be directed to the manual control section. And if the problem persists, the said suitcase should be taken out of BHCS.

C. Merging the baggage transferred

One of the most important operations in BHCS is to merge the transfer bags with the arriving bags at the first section. The transferred bags should be passed through RFID Readers so as to make sure of lack of any problem with them. The routine trend conducted in the previous stages should also be conducted for such bags. Finally, considering the information stored in their tags, the merging operation is carried out.

D. Conforming suitcases to passengers

One of the problems of airlines is the mistaken transfer of a bag and or the boarding of a passenger without their baggage being loaded in the transport system. Such a problem has caused many financial losses and huge time is wasted to obviate such a problem in airports. Many delays are the result of such problem in the traditional system. With the intended system being used, a passenger and his/her bags can be easily controlled and observed during a flight as the information related to each passenger and his/her baggage is stored in the related tags and each passenger has a separate tag with a special number, which is stuck to all his/her bags. If a passenger boards in but their baggage is not loaded or mistakenly taken by another passenger, the system instantaneously informs the controller and this problem is removed quickly. As RFID Readers are used in all sections of an airport, the path of passengers and their baggage is thoroughly monitored and tracked. Traceability in BHCS Cycle is one of the most important specifications of RFID Tags. The earlier stages are thoroughly elucidated in Fig. 5.

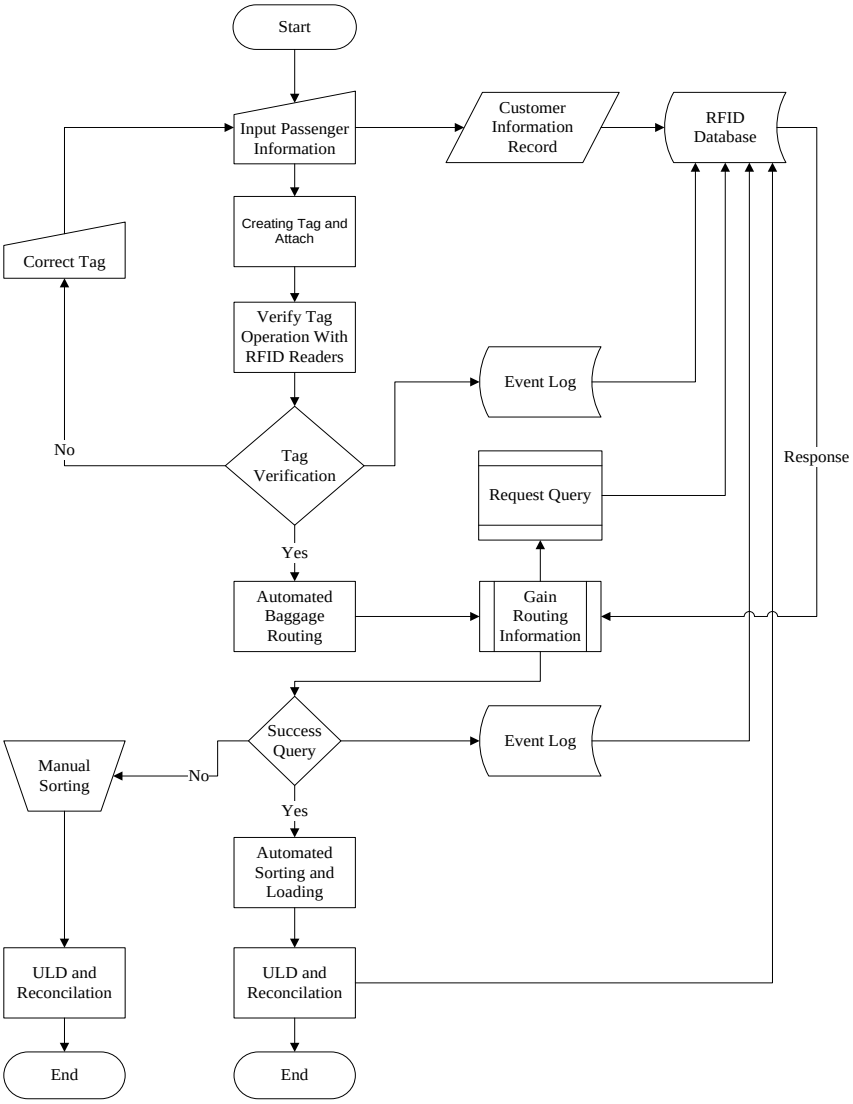

Figure5 Flowchart Of BHCS System

IV. SYSTEM EFFICIENCY TEST

Here, simulation has been used to obtain the system productivity and efficiency considering the hypotheses of the problem. In this simulation, it has been tried to simulate all components of a BHCS System together with the rates of existing errors and their runtime in a real environment. The results are then analyzed. In this problem, 300 bags are produced with a monotonous distribution and randomly in the system. According to what was stated in this research, four RFID Readers are located in a compartment over a conveyor belt with a 5% error and the service time of Ts=0.001. In a real system, the places allocated to RFID Readers were studied. And in this simulation, these readers were used in three places, two before and one after EDS, in order to obtain the number of out-of-service baggage.

A reader was used before loading in order to make sure that both passenger and their baggage have boarded.This is the vital point of the system. The rate of queue defined in the system is indefinite; and a monotone function with parameters 20 & 40 is used in the system (Q_S=UNFRM(20,40)).Finally, Average waiting time obtained together with the parameters defined and the service rate of its components for the system is shown in Fig. 6.

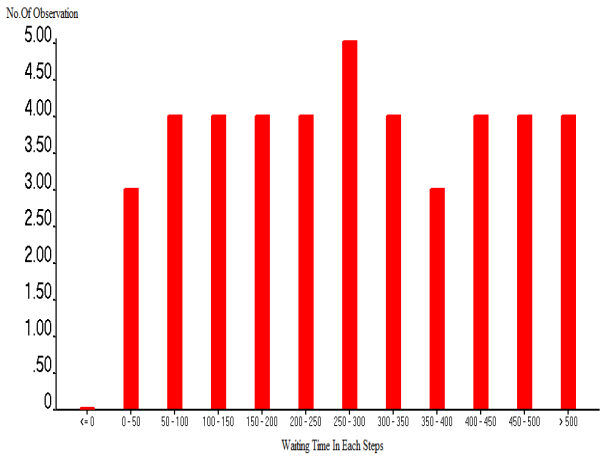

Figure 6 Averaging Waiting Time

The efficiency of RFID Readers is one of the most important parameters for the system. The efficiency rate of one of these readers is shown in Fig. 7.

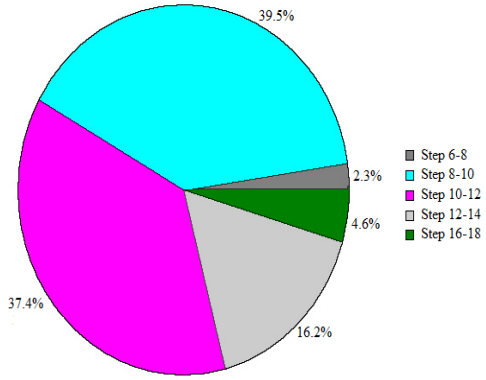

Figure 7 Performances of RFID Readers

As a relatively appropriate error percentage is allocated to this system, acceptable efficiency has been obtained for the samples observed. In order to obtain the efficiency of this reader, the number of the bags passing through this reader as well as the number of active entities on the system is required. By dividing these two factors and obtaining its percentage, the efficiency rate of the reader can be obtained.

V. CONCLUSION

RFID Technology is one of the most popular technologies used in various industries of today. The main objective of designing the intelligent BHCS System is to convey the input data to the system output with the least error coefficient and decreased cost in the system. For example, in a traditional system, a barcode check requires manpower's precision and patience and in the absence of these two parameters, the main objective of the system will not be realized. In a designed system whose most important property is to track objects and men by intelligent tags, prevention of any loading delay, traceability of baggage and passengers in an airport and during the flight are underlined. By upgrading the present systems into intelligent ones in an airport, not only are the abovementioned advantages provided, but the airport security is highly promoted. This way, any insecurity in the system will be very easily tracked and reported to the system. Other important advantages of these systems include the saving of time, shorter queues, easier traceability and provision of passenger's security, which have changed an airport into a friendly and more convenient place for the passengers. This study presents a new model with four parameters for storing the information of passenger and baggage in the memory of a tag, which is used to track the intended entity in the whole system. The tag nature is one of the information stored in the memory for more easily tracking. With this option, one can find out the type of the tag stuck (passenger, handbag or suitcase). To define such a pattern help the system simplify the traceability and identification processes. In the present systems studied so far, only the name of a plane together with a accidentally made code are stored in a tag. It is true that the pursuit and tracking are carried out, but the nature of the pursued factor is not determined. The use of appropriate number of RFID Readers in all over the airport for easier checking and pursuing are among the main factors, which have been studied in the conducted simulation. The paper has dealt with the whole system from the arrival of passengers and their baggage at an airport up to the time of their boarding and loading in four sections. One of the most important sections of the system is the boarding of passengers and the loading of their baggage into a plane and if a passenger boards a plane but their baggage is not loaded in that plane or vice versa, that plane will not receive the flight permission. As a result, the design of the permissible error rate at the vital point of a system is of very high importance.

BHCS System is very comprehensive and important a system in the airline industry and a lot of works should be done and state of the art technologies are required to achieve highest customer satisfaction. RTFID Technology together with nervous networks to learn part of the airport works and to simplify the operation of the system is another novel idea, which may be one day used in this industry.

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